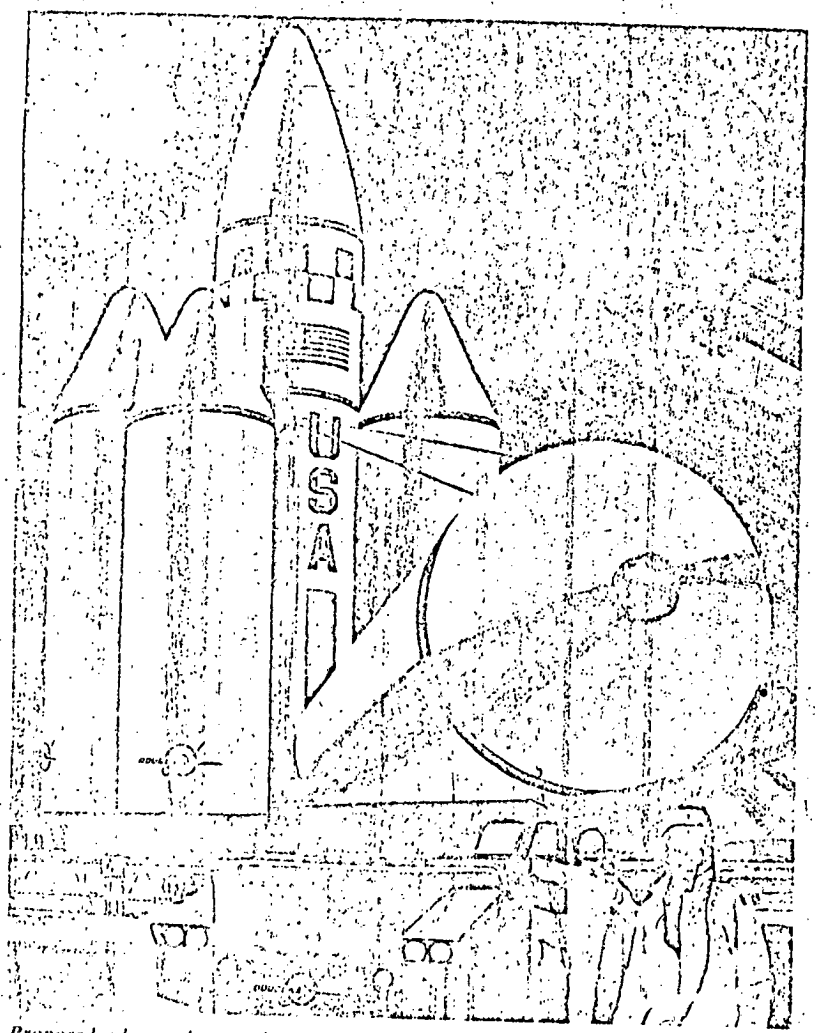
SPECIAL REPORT

Man's Utility in Space Stressed at AIAA



Proposed advanced space launch vehicle was described by a Douglas Missile and Space Systems Div. engineer at Third Annual AIAA Meeting held Nov. 29-Dec. 2 in Boston. Basic single-stage booster is 50 ft. in diameter and 200 ft. long.

BOSTON—The manned spaceflight program is the most successful technological feat ever undertaken by this nation, according to Dr. Edward Welsh, executive secretary of the National Aeronautics and Space Council.

With that statement, he set the key for a panel discussion by U.S. space experts of the future of the U.S. space program at the Third Annual Meeting of the American Institute of Aeronautics and Astronautics (AIAA). Those on the panel included Gen. Bernard S. Schriever, USAF (ret.), Dr. George E. Mueller, director of NASA's manned spaceflight programs, Rep. George P. Miller (D-Calif.), chairman of the House Committee on Science and Astronautics, and J. F. MacDonald of the Institute for Defense Analyses.

Gen. Schriever said the emphasis on space activities should not only be on peaceful purposes but also on preservation of space. He said this would inevitably require the sending of military men into space.

Noting that there is a large school of thought which believes that man is a "fifth wheel" in space, Schriever said this "goes against the experience of mankind over the ages." Man has proved his worth on land, sea and air, he said, then asked "why is it so difficult to imagine man filling this role in space?"

It is "wishful thinking" to believe that man ultimately will not be put in space for military purposes.

Advances in technology, he said, will not stop despite the belief of some people that they will. The space program, he said, must get away from the "throw-away" concept and mature into hardware that calls for manueverable re-entry vehicles and recoverable boosters. This requires a space vehicle that can re-enter and land on runways, he said.

This was echoed by NASA's Mueller, who also forecast the development of an aerospace plane. He said there will be manned space stations that can stay in orbit for a year or longer but agreed with the other panelists that there was no need for crews to stay aloft that long. A ferry vehicle would be used for re-supply of both equipment and crew, he said.

Reconnaissance satellites admitted—The first official acknowledgement that the U.S. is using unmanned satellites for reconnaissance of the Soviet Union was made during the panel discussion by Rep. Miller.

He declined to name the well-known projects engaged in this endeavor but pointed out that the USSR is engaged in similar activity.

Miller later said one of the problems facing the House Space Committee was that of educating the people of the nation to the benefits of the space program. It is a difficult task, he said, to justify space expenditures against the costs of Vietnam, foreign aid and Great Society projects.

But, he insisted, it is the translation of space technologies into useful benefits that is the overall value of the space program.

U.S. and Soviet efforts—"We know a fair amount about what the Russians are doing (in space work) but we don't

TECHNOLOGY WEEK'S special report on the AIAA meeting was prepared by Senior Editors Charles LaFond, William Beller and John Judge, and Associate Editor Ron Barnhart.

know their schedule," Dr. Welsh told a press conference following the Nov. 29 panel.

Expressing surprise that the Soviet Union has not done more in manned spaceflight since 1964 than they have, Welsh noted the benefits the Russians are accruing from the U.S. manned spaceflight effort. Among these is the certain knowledge that "rendezvous and docking can be done in an orderly manner," he said.

On the other hand, the Soviet Union is putting high emphasis on interplanetary and lunar activities. "To the best of our knowledge, (the nation) has a manned lunar program," said Welsh. "I see no reason to disbelieve it."

Turning to the question of the U.S. and the USSR cooperating in spacecraft tracking, Welsh said, "we would be happy to work out a mutual arrangement with the Russians . . . but we don't want it to be one-sided."

Welsh is "not particularly encouraged by the Joint (Russian-U.S. Meteorological Program." He revealed that the Russians stopped sending meteorological data from their satellites "some weeks ago." Welsh suggested that perhaps their equipment is no longer working.

"Their pictures may not have been as clear as ours," said Welsh, but they showed that the Soviet Union can build sophisticated meteorological satellites.

Asked if a "space gap" exists between the Soviet Union and the U.S., Welsh answered that the U.S. assuredly leads in total number of manned spaceflight hours "but not necessarily in spacecraft weight (flown)."

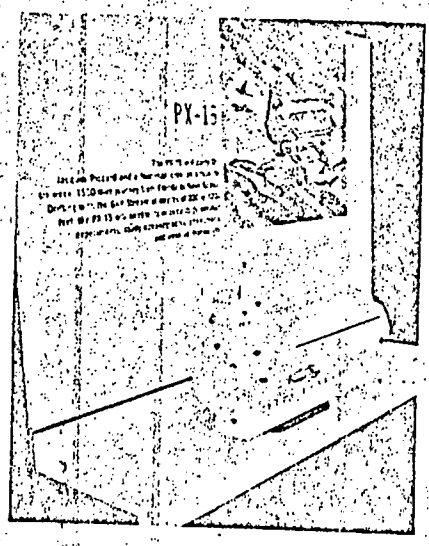
Program diversified—Five themes were interwoven thoughout the four-day (Nov. 29-Dec. 2) technical program: science experiments, air transportation, aerospace technology utilization, manned orbital flight, and propulsion systems. These were covered in 46 lecture and panel sessions. In addition, four "forums" were held to cover marine systems, management, reliability and maintainability, and the process of innovation in developing aerospace technology.

An attendance comparable to last year's San Francisco meeting (about 4,500) was expected. The 2,200 early arrivals were fairly thinly spread throughout the spacious Sheraton-Boston/War Memorial Auditorium complex here.

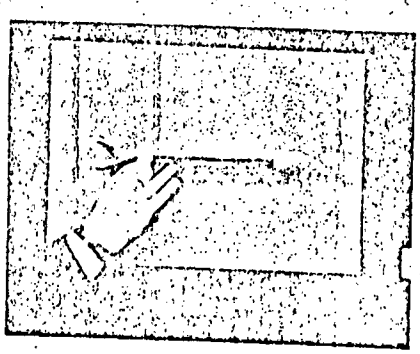
For the Fourth Annual Meeting, to be held in the new Anaheim Convention Center and Disneyland Hotel, Oct. 23-27, 1967, in southern California, a record attendance of 7,000-8,000 is anticipated by chairman Dr. Lawrence L. Kavanau. The facility will be completed by March of next year, the Systems Associates, Inc., president disclosed.

A completely new program is already under way that will attempt to use the best approaches employed during the last two meetings. A combination technical program will include both theme and conventional technical paper presentations. To satisfy both attendees and exhibitors, Kavanau said, the committee is looking for better ways to couple the technical sessions with the exhibit hall, providing at least some periods of minimum conflict in time.

The major themes that will be emphasized next year, the conference chairman told TECHNOLOGY WEEK, are safety in manned operations (space, air and undersea), urban air transportation (problems of the megalopolis), and space for commerce (more from research to practical application).



ABOVE: *PX-15 submersible being built by Grumman was part of firm's exhibit. Vessel will be used in Gulf Stream study.* BELOW: *Avco Corp. displayed miniature tactical missile decoys weighing just 2.52 lbs. Unit shown is 11.2 in. long and 0.8 in. in diameter, but gives same radar cross-section and flights dynamics as a missile, and can be deployed in flights of five.*



A quick look through the displays of the 85 exhibitors at this year's meeting provided a full range of the aerospace technological spectrum to attendees and an obvious view of the impact of the supersonic transport race on today's industrial scene.

While much of the show may not have been new to some aerospace experts, nearly every booth provided at least one major innovation in either product or technique. Typical of these are the few described below by TECH WEEK editors. Most were considerably amplified by the lecture-demonstrations used so effectively by exhibitors in the booth area.

Tactical missile decoys—The Avco Corp. revealed a micro-decoy for tactical missiles, but company spokesmen were tight-lipped regarding its application to specific missiles. The micro-decoy displayed was 11.2 in. long and 0.8 in. in diameter and weighed 2.52 lbs. It was designed to give the same radar cross-section and flight dynamics as a live missile. The decoy's principal scatterer is a dielectric rod reflector.

The decoys can be deployed in coveys of five, the entire package weighing 17.3 lbs. The decoys are mounted with their roll axes parallel to the missile skin, to minimize air drag, and ejected by squibs.

Avco says there are no "high-risk items" in the package. The company names the following advantages for its micro-decoys:

—No missile maneuvers are required to eject them.

—Separation velocities are varied between decoys to achieve proper circular pattern and distance between decoys.

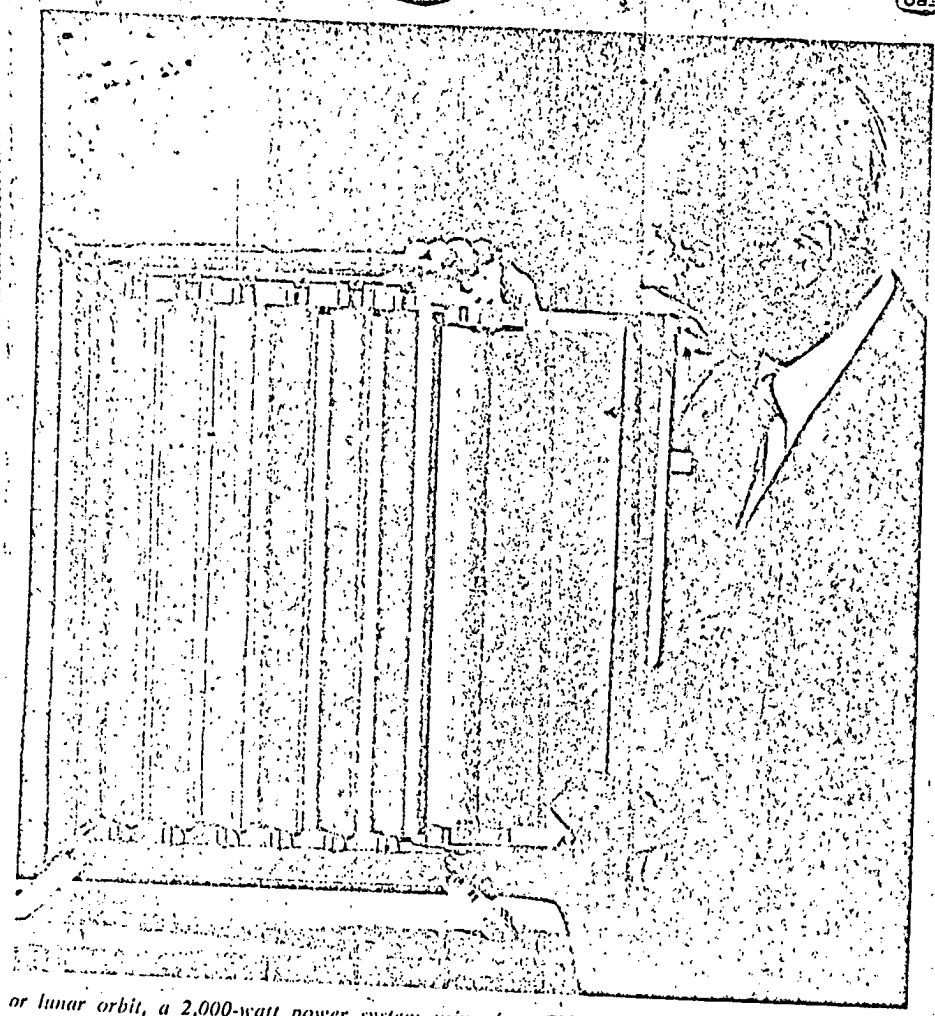
—The missile is allowed to occupy any position on the circumference of the pattern, and therefore cannot be discriminated by its pattern position.

—The system does not effect offense targeting doctrine or degrade missile accuracy.

Avco concludes that the net effect is "one missile launch provides six credible threats to the defense."

Apollo extrapolations—The *Saturn* S-1VB stage is being groomed for space missions extending into the mid-1970's. One model exhibited by General Electric's Missile & Space Div. showed a spent S-1VB outfitted in orbit by accompanying astronauts to support them for 90-120 days. Design details for this concept stemmed from a study initiated by Marshall Space Flight Center on S-IVB spent-stage utilization, for which RFP's were to be answered this past Nov. 7. Winning company will get a contract of about $400,000 running for nearly a year.

This Marshall study will in effect extend the *Apollo* alternate "209" program, aimed at an April, 1968, flight date, in which *Apollo* astronauts in Earth orbit will descend from their



or lunar orbit, a 2,000-watt power system using four SNAP-29's for main power. Drawing shows Apollo Command and Service Module separated from S-IVB, turned around and docked with it. Generators are mounted on Saturn Instrument Unit (IU). ABOVE: *Douglas G. Harvey, SNAP-29 program director at Martin-Baltimore, inspects half-scale model of the isotopic system displayed at AIAA meeting in Boston. Martin is developing SNAP-29 for short-term (up to 90-day) missions under $10-million-plus contract from AEC.*

cussed at the EG&G, Inc., booth by its inventor and first user, Charles W. Wyckoff, manager of the firm's photo sciences department.

Wyckoff, who gained wide reputation a few years ago for developing a black-and-white film with extended sensitivity range of 1 to 100 million, emphasized that the new XR color film is still in the experimental stage but probably will be available in time for use in the first U.S. lunar landing. The color film has a sensitivity range from ASA 1 to ASA 1,000. It was originally developed for photographing nuclear explosions but is ideally suited to lunar surface photography, Wyckoff stated.

The first practical application of the new color film occurred earlier this month in the jungles of Brazil during the solar eclipse. Wyckoff was among the scientists who traveled to South America to participate in observations and experiments during the total eclipse.

The photographs taken on the XR color film at totality showed the corona, solar flares, and prominences with great detail and clarity. Information recorded on one single frame of the new color material was contained in bits and pieces in three or four separate frames of conventional color film, each of which was shot at different shutter speeds and lens openings.

The XR color film combines on one base a number of different emulsions of varying sensitivities, so it is virtually impossible to over- or underexpose it, explained Wyckoff. Thus it is possible to load a simple box camera with this material, take a picture in bright sunlight, and then, on the next frame, shoot an indoor scene using only lightbulbs for illumination. Both pictures would come out perfectly, with true color fidelity, Wyckoff asserted.

He pointed out in his demonstration-lecture that the extremely wide range of lightlevels on the Moon will require a film of extreme sensitivity latitudes. He explained that due to the Moon's lack of atmosphere or cloud cover, which normally tends to scatter light, contrast ratios on the surface between shadow and light may well be 1 to 10,000 and possibly larger.

The non-modeling nature of the lunar terrain also was demonstrated by the EG&G photo scientist. By illuminating a lunar landscape model with a spotlight, he demonstrated that when the Sun is directly overhead, in front of, or behind an astronaut standing on the surface, depressions, elevations or other ground or surface features would not be visible. Not only would the astronaut be unable to take meaningful photographs at such times, but he would be in danger of falling or stumbling. Only when the Sun is to the side of the observer, Wyckoff stated, can he see and photograph surface features.

Jet composites—More than 300 parts in one of General Electric's newest jet engines are fabricated from composite materials. The specific engine was not identified by GE propulsion experts.

A test blade exhibited by the firm contained 57% boron filament together with unidirectional glass filaments and shell epoxy resin. The blade is part of an investigative program at GE funded by the Air Force Materials Laboratory. It is not part of the composite engine.

The blade was processed from preforms and subassemblies and then press-molded into final shape. The blade can operate continuously at 250°F, and GE spokesmen claim the unit has exceeded design goals at less than 50% the weight of titanium.

GE's contender in the SST engine race used the so-called wonder metal fairly extensively. The GE 4 SST engine used titanium in the front half of the compressor—including the front shaft and the front casing.

A glass-fiber reinforced, plastic variable-vane shroud is being studied by GE for potential use in the first four stages of the J79 engine.

The materials in this part have high structural integrity while operating continuously at 500°F.

GE's advanced jet engines will use the full annular combustor concept. The annular design has been flight-proven for several years.

The design has a number of liners which tend to produce an uneven temperature profile at the turbine inlet. In addition, the crossfire tubes between the liners are subject to high thermal gradients.

GE engineers say the annular design eliminates operational and maintenance problems associated with high-temperature gradients because the gas flow is much smoother and the temperature profile is more uniform. □

Command and Service Module into into their spent S-IVB stage and attempt to set up "housekeeping" there for 30 days.

In describing the Marshall study, Marvin F. Clarke, MSD manager of design engineering, advanced manned systems engineering, said the program "is going to give AAP a real run for its money."

Looking at a concept using the S-IVB in the early and mid-1970's, Clarke showed TECH WEEK the stage as it would be outfitted on the ground prior to its launch as the payload stage atop the first two *Saturn V* stages. This version in orbit would prepare man for interplanetary flight, according to Clarke. It would be able to support nine men in a 260-n.mi. orbit "for a year without resupply," Clarke said. Payload weight would be about 240,000 lbs., included in the 13,000-cu.-ft. volume of the S-IVB and in the 600-cu.-ft. volume of the Command and Service Module and adapter stage where Lunar Module would ordinarily be housed.

Manned interplanetary vehicle—The manned Mars mission including landing can be done by the early 1980's, if backed as a national goal, according to Gordon Coates, MSD program manager for studies of manned interplanetary vehicles. Pointing out several modeled versions of spacecraft that could perform the mission, Coates noted that MSD studies show that "an optimum combination of nuclear-electric, nuclear-rocket and chemical-rocket propulsion offers a much greater performance potential than does the optimized combination of just nuclear-rocket and chemical-rocket for manned interplanetary missions."

The GE study centers on a manned Mars mission and envisions carrying a crew of eight, four of whom will land on the planet. Specifically, the spacecraft is assembled in orbit, requiring six *Saturn V* launches to carry up the needed hardware. A *NERVA II* nuclear rocket then launches the spacecraft out of Earth orbit toward Mars. Then the nuclear electric propulsion system takes over, giving thrust to the spacecraft, then letting it coast, and giving it thrust again as the vehicle nears Mars.

A chemical rocket stage brakes the spacecraft into Mars orbit. The Mars excursion module departs for the surface, subsequently returns, and the spacecraft departs for Earth, powered first by chemical propulsion and then by electric. The crew enters Earth orbit in a special module, having discarded the interplanetary spacecraft while still in solar orbit.

Advances in microminiaturization—In an effective demonstration of past, present, and future microminiaturization techniques, Radio Corp. of America compared a typical satellite clock subsystem as fabricated from discrete transistor components, planar-integrated circuits, IC flexible-film techniques, and metal-oxide-silicon field-effect-transistor (MOSFET) arrays.

Thus, in showing the satellite-attitude clock fabricated from discrete transistors and other components used in the early *Tiros* series in 1962, RCA demonstrated a 7 to 1 reduction in size and weight with a similar unit fabricated from bipolar planar-integrated circuits. The later, which came into use in 1963, employed some 60 integrated circuits and easily passed all *Tiros* environmental tests, the firm said.

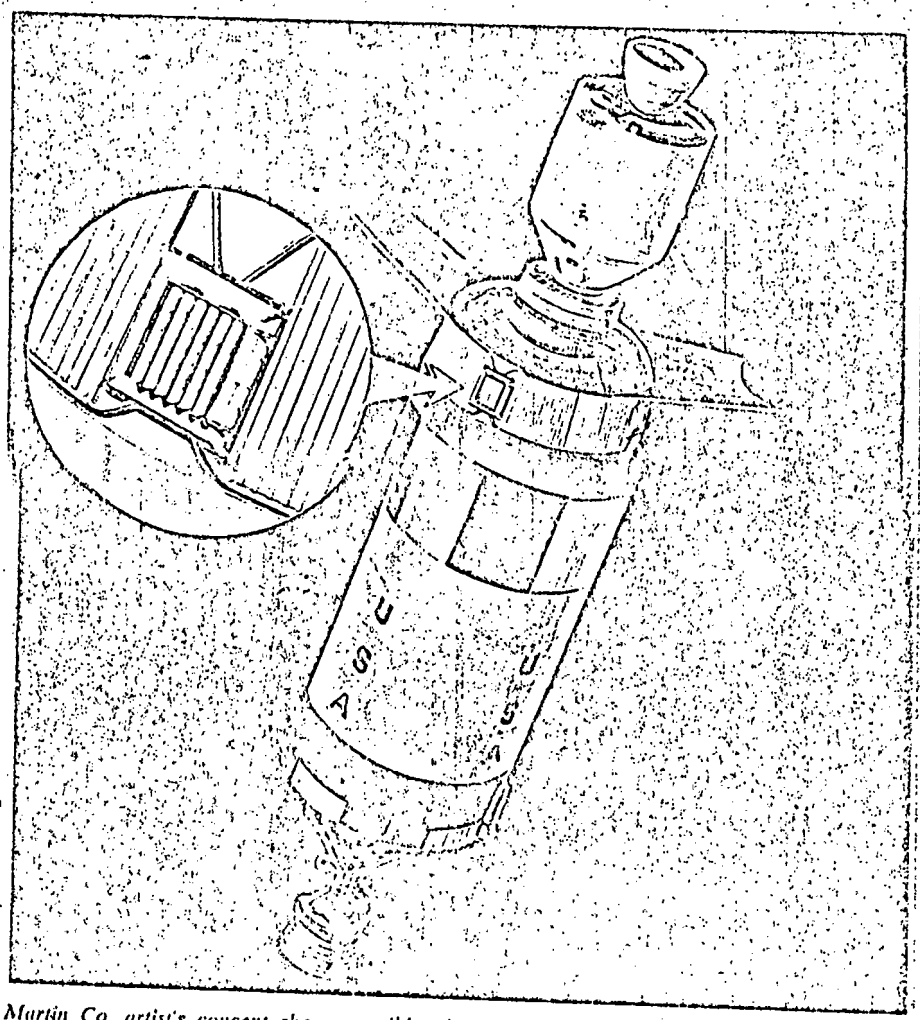
This, said RCA, led to a more complex version used in *ESSA II* but employing 420 integrated circuits. The latter device is still functioning perfectly after nine months in orbit. Average power requirement is 0.1 watt.

Expanding the technique into many parts of the command and control system for *ESSA III*, some 500 integrated circuits are now used, RCA said.

Now in development by the firm is an advanced version of these subsystems using integrated-circuit flexible-film. The film, measuring two mils in thickness, is expected to offer a 20 to 1 saving in size and weight over the planar integrated-circuit structure.

For the future RCA is looking toward use of the MOSFET arrays, which will offer up to a 400 to 1 improvement in size and weight over the planar IC fabrication technique. Using complementary MOS packages, RCA predicts a power saving of up to 1,000 to 1 over a comparable integrated-circuit package. The firm predicts that subsystems employing such advanced techniques will appear in operational flight hardware by the 1967-68 time period.

XR color film report—The results of the first practical application of an extended-range (XR) positive color film material was demonstrated and dis-



Martin Co. artist's concept shows possible placement of SNAP-29 nuclear generators, each supplying 500 watts of electricity, on manned space station provided by spent S-IVB stage of Saturn launch vehicle. Two of four generators involved are shown flanked by their heat rejection radiators. NASA is studying a post-Apollo mission for such a vehicle, called the S-IVB workshop, which would last up to 30 days and use fuel cells as the primary power source. Space agency has asked Martin to study, for missions of longer than 30 days in Earth